United States
Department of
Agriculture

**Forest
Service**

Forest
Products
Laboratory

Dividends From Wood Research

Recent Publications

July–December 2000

Explanation and Instructions

"Dividends From Wood Research" is a semiannual listing of recent publications resulting from wood utilization research at the Forest Products Laboratory (FPL). These publications are produced to encourage and facilitate application of Forest Service research. This issue lists publications received between July 1 and December 31, 2000.

Each publication listed in this brochure is available through at least one of the following sources.

Available from FPL (indicated by an order number before the title of the publication): Quantities limited. Circle the order number on the blank at the end of the brochure and mail or fax the blank to FPL.

Available through the Internet: Listed publications are available as PDF documents for viewing or printing from FPL's web site (http://www.fpl.fs.fed.us/).

Available through sales outlets: Major sales outlets are the Superintendent of Documents, the National Technical Information Service (NTIS), and various private publishers. Order directly from the outlet.

Available through libraries: Research publications are available through many public and university libraries in the United States and elsewhere. U.S. Government publications are also available through many Government Depository Libraries. Check with a major library near you to determine availability.

List of Categories

Publications are listed in this brochure within the following general categories:

- Biodiversity and Biosystematics of Fungi
- Decay Processes and Bioprocessing
- Durability
- Papermaking and Paper Recycling
- Properties and Use of Wood, Composites, and Fiber Products
- Recycling of Wood Products
- Surface Chemistry
- Timber and Fiber Demand and Technology Assessment

Biodiversity and Biosystematics of Fungi

Incompatibility Groups Among North American Populations of *Laetiporus sulphur*eus sensu lato

Banik, Mark T.; Burdsall, Harold H. Jr.
2000. Mycolgia. 92(4): 649–655.

Contributions to the Study of Gasteromycetes of Puerto Rico

Nieves–Rivera, Angel M.; Lodge, D. Jean; Miller, Orson K., Jr.
1998. McIlvainea. 13(2): 50–58.

Decay Processes and Bioprocessing

CCA Removal From Treated Wood Using a Dual Remediation Process

Clausen, Carol A.
2000. Waste Manage Res. 18: 485–488.

Correlation Between Oxalic Acid Production and Copper Tolerance in *Wolfiporia cocos*

Clausen, C.A.; Green, F., III; Woodward, B.M.; Evans, J.W.; De Groot, R.C.
2000. Int. Biodeter. & Biodegrad. 46: 69–76.

Isolating Metal-Tolerant Bacteria Capable of Removing Copper, Chromium, and Arsenic From Treated Wood

Clausen, Carol A.
2000. Waste Manage. Res. 18: 264–268.

Inhibition of Decay Fungi Using Cotton Cellulose Hydrolysis as a Model for Wood Decay

Green, Frederick, III
2000. Int. Biodeter. & Biodegrad. 46: 77–82.

Mechanisms for Kappa Reduction and Color Removal by Xylanases

Jeffries, Thomas W.; Davis, Mark; Rosin, Brian; Landucci, Larry L.
1998. *In*: Proceedings, 7th international conference on biotechnology in the pulp and paper industry; 1998 June 16–19; Vancouver, BC, Canada. Montreal, Quebec, Canada: Canadian Pulp and Paper Assoc. Poster presentations. Vol. C.: C41–C43.

Degradation of Nonphenolic Lignin by the Laccase/1-Hydroxybenzotriazole System

Srebotnik, Ewald; Hammel, Kenneth E.
2000. J. Biotech. 81: 179–188.

A Homokaryotic Derivative of a *Phanerochaete chrysosporium* Strain and Its Use in Genomic Analysis of Repetitive Elements

Stewart, Philip; Gaskell, Jill; Cullen, Daniel
2000. Appl. Environ. Microb. 66(4): 1629–1633.

Durability

Proceedings of the 12th International Symposium on Nondestructive Testing of Wood; 2000 September 13–15; University of Western Hungary, Sopron

Divos, Ferenc, ed.
2000. Sopron, Hungary: University of Western Hungary.

Detection of Wetwood in Green Red Oak Lumber by Ultrasound and Gas Chromatography-Mass Spectrometry Analysis
Brashaw, Brian K.; Adams, Roy D.; Schafer, Mark S.; Ross, Robert J.; Pettersen, Roger C.
2000. 49–56.

Comparison of Several Nondestructive Evaluation Techniques for Assessing Stiffness and MOE of Small-Diameter Logs
Ross, Robert J.; Wang, Xiping; Mattson, James A.; Erickson, John R.; Forsman, John W.; Geske, Earl A.; Wehr, Michael A.
2000. 155–163.

Nondestructive Structural Evaluation of Wood Floor Systems in Historic Buildings
Soltis, L.A.; Hunt, M.O.; Ross, R. J.; Wang, X., Cai, Z.
2000. 279–288.

Nondestructive Evaluation of Standing Trees With Stress Wave Methods
Wang, Xiping, Ross, Robert J.; Erickson, John R.; Forsman, John W.; McClellan, Michael; Barbour, R. James; Pellerin, Roy F.
2000: 197–206.

Patterns of Long-Term Performance—How Well Are They Predicted From Accelerated Tests and Should Evaluations Consider Parameters Other Than Average?

De Groot, Rodney C.; Evans, James W.
1998. *In*: Proceedings of The International Research Group of Wood Preservation, 29th annual meeting; 1998 June 14–19; Maastricht, The Netherlands. Stockholm, Sweden: The International Research Group on Wood Preservation Sec. 2, Document IRG/WP 98–20130.

Drying Hardwood Lumber

Denig, Joseph; Wengert, Eugene M.; Simpson, William T.
2000. USDA Forest Serv. Gen Tech. Rep. FPL–GTR–118. 138 p.

Drying Hardwood Lumber focuses on common methods for drying lumber of different thickness, with minimal drying defects, for high quality applications. The manual also includes predrying treatments that, when part of an overall quality-oriented drying system, reduce defects and improve drying quality, especially of oak lumber. Special attention is given to drying white wood, such as hard maple and ash, without sticker shadow or other discoloration. Several special drying methods, such as solar drying, are described, and proper techniques for storing dried lumber are discussed. Suggestions are provided for ways to economize on drying costs by reducing drying time and energy demands when feasible. Each chapter is accompanied by a list of references. Some references are cited in the chapter; others are listed as additional sources of information.

(A free printed copy of this report can be obtained from the Publications Department, Wood Education and Resource Center, 301 Hardwood Lane, Princeton, WV 24740, Attn: Clyde Meador Fax: (304) 487–6661, E-mail: educaiton@werc-hdw.com)

Correlation of Smoke Development in Room Tests With Cone Calorimeter Data for Wood Products

Dietenberger, Mark A.; Grexa, Ondrej
2000. *In*: Osvald, Anton, ed. Proceedings of Wood & Fire Safety, 4th international scientific conference, Pt. 1; 2000, May 14–19; Palria, Strbske Pieso, Slovak Republic. Zvolen, Slovakia: Faculty of Wood Technology, Technical University of Zvolen: 45–55.

Flame Retardant Treated Wood Products

Grexa, Ondrej
2000. *In*: Osvald, Anton, ed. Proceedings of Wood & Fire Safety, 4th international scientific conference, Pt. 1; 2000, May 14–19; Palria, Strbske Pieso, Slovak Republic. Zvolen, Slovakia: Faculty of Wood Technology, Technical University of Zvolen: 101–110.

An Inverse Moisture Diffusion Algorithm for the Determination of Diffusion Coefficient

Liu, Jen Y.; Simpson, William T.; Verrill, Steve P.
2000. *In*: Kerkhof, P.J.A.M.; Coumans, W.J.; Mooiweer, G.D. Proceedings, 12th international drying symposium; 2000 August 28–31; Noordwijkerhout, The Netherlands. EFCE event no. 613.

Shear Test Fixture Design for Orthotropic Materials

Liu, Jen Y.
2000. *In*: Hui, D., ed. Proceedings, Seventh annual international conference on composites engineering; 2000 July 2–8; Denver, CO. New Orleans, LA: University of New Orleans, International Community for Composites Engineering and College of Engineering: 553–554.

▷ **1. Commentary on Factors Affecting Transverse Vibration Using an Idealized Theoretical Equation**

Murphy, Joseph F.
2000. USDA Forest Serv. Res. Note FPL–RN–0276. 4 p.

An idealized theoretical equation to calculate flexural stiffness using transverse vibration of a simply end-supported beam is being considered by the American Society of Testing and Materials (ASTM) Wood Committee D07 to determine lumber modulus of elasticity. This commentary provides the user a quantitative view of six factors that affect the accuracy of using the idealized theoretical equation, idealized assumptions, and idealized boundary conditions. The six factors that affect the calculation of the flexural modulus of elasticity are ranked in order of importance, and recommendations are given. Not covered are the precision and accuracy of the physical measurements.

Preliminary Investigation on the Natural Durability of Guayule (*Parthenium argentatum*)-Based Wood Products

Nakayama, Francis S.; Chow, Poo; Bajwa, Dilpreet S.; Youngquist, John A.; Muehl, James H.; Krzysik, Andrzej M.
2000. *In*: Proceedings, 31st annual meeting of the International Research Group on Wood Preservation; 2000 May 14–19; Kona, Hawaii. Stockholm, Sweden: The International Research Group on Wood Preservation: IRG/WP 00–40154.

▷ **2. Estimates of Air Drying Times for Several Hardwoods and Softwoods**

Simpson, William T.; Hart, C.A.
2000. USDA Forest Serv. Gen. Tech. Rep. FPL–GTR–121. 70 p.

Published data on estimated air drying times of lumber are of limited usefulness because they are restricted to a specific location or to the time of year the lumber is stacked for drying. At best, these estimates give a wide range of possible times over a broad range of possible locations and stacking dates. The report describes a method for estimating air drying times for specific locations by optimizing a drying simulation using existing experimental air drying times for northern red oak, sugar maple, American beech,

yellow-poplar, ponderosa pine, and Douglas-fir. The results are simulation parameters that make it possible to estimate the air drying times of these species regardless of when they are stacked, in any location where average temperature and relative humidity are known, and for lumber of any thickness dried to any final moisture content. Graphs of these estimated air drying times to several final moisture contents are given for several nominal thicknesses of lumber at various locations within the growing range of the six species studied.

▷ **3. Power Calculations in the Predictor Sort Computer Program**

Verrill, Steve P.; Green, David W.; Herian, Victoria L.
2000. USDA Forest Serv. Res. Note FPL–RN–0277. 4 p.

In a series of papers Verrill, Green, and Herian have developed theory and a computer program to aid in the design and analysis of predictor sort experiments. The report provides the mathematical justification for the power calculations that the predictor sort program implements.

Charring Rate of Composite Timber Products

White, Robert H.
2000. *In*: Osvald, Anton, ed. Proceedings of Wood & Fire Safety, 4th international scientific conference, Pt. 1; 2000 May 14–19; Palria, Strbske Pieso, Slovak Republic. Zvolen, Slovakia: Faculty of Wood Technology, Technical University of Zvolen: 353–363.

Fire Performance of Hardwood Species

White, Robert H.
2000. In: Forests and society: the role of research. Proceedings, 11th IUFRO World Congress; 2000 August 7–12; Kuala Lumpur, Malaysia. 13 p.

Papermaking and Paper Recycling

Process Water Recovery: Dissolved Air Flotation Compared to High Shear Rate Separation

Klungness, John H.; Tan, Freya; Gleisner, Rolland, Abubakr, Said
1998. In: Proceedings of the 1998 TAPPI Recycling Symposium; 1998 March 8–12; New Orleans, LA. Atlanta, GA: TAPPI Press: 123–132.

Beneficial Use of Pulp and Paper Industry Residuals: Extrusion for the Manufacture of Building Panels

Scott, C. Tim; Simonsen, John; Klingenberg, Dan; Zauscher, Stefan
2000. Tech. Bull. 814. National Council for Air and Steam Improvement. 10 p.

Beetle-Killed Spruce Utilization in the Kenai Peninsula

Scott, Gary M.; Bormett, David W.; Ross Sutherland, Nancy; Abubakr, Said; Lowell, Eini
2000. Tappi J. p. 48. (June)

Pulp Extrusion for Recycling Wastepapers and Paper Mill Sludges

Zauscher, Stefan; Scott, C. Tim; Willett, J.L.; Klingenberg, Daniel J.
2000. Tappi J. p. 62. (June)

Properties and Use of Wood, Composites, and Fiber Products

Bridges, Other Structures, and Hydraulics and Hydrology. Proceedings, 5th international bridge engineering conference; 2000, April 3–5; Tampa, FL. Transportation Research Record 1696. Transportation Research Board–National Research Council. Washington, DC: National Academy Press.

Wood in Transportation Program—An Overview

Duwadi, Sheila Rimal; Ritter, Michael A.; Cesa, Edward
2000. Pap. No. 5B0105. 1: 310–315.

Reliability-Based Criteria for Load and Resistance Factor Design Code for Wood Bridges

Eamon, Chris; Norwak, Andrzej S.; Ritter, Michael A.; Murphy, Joe
2000. Pap. No. 5B0016. 1: 316–322.

Two Test Level 4 Bridge Railing and Transition Systems for Transverse Timber Deck Bridges

Faller, Ronald K.; Ritter, Michael A.; Rosson, Barry T.; Fowler, Michael D.; Duwadi, Sheila R.
2000. Pap. No. 5B0110. 1: 334–351.

Evaluation and Field Load Testing of Timber Railroad Bridge

Wipf, Terry J.; Ritter, Michael A.; Wood, Douglas L.
2000. Pap. No. 5B0112. 1: 323–333.

Proceedings: Linking Healthy Forests and Communities Through Alaska Value-Added Forest Products; 1999 September 27–28; Sitka, Alaska. USDA Forest Serv. Gen. Tech. Rep. PNW–GTR–500

Grading Options for Western Hemlock Pulp Logs

Green, David W.; McDonald, Kent A.; Dramm, John; Kilborn, Kenneth
2000: 73–75.

Workshop Summation: Alaska Value-Added Forest Products

Laufenberg, Theodore
2000: 317–322.

The Southeast Alaska Timber Resource and Industry: What Might the Future Hold?

Zaborske, Richard R.; McClellan, Michael H.; Barbour, Jamie; Laufenberg, Theodore L.; Shaw, Charles G. "Terry"
2000: 23–26.

Aldehyde Emissions From Particleboard and Medium Density Fiberboard Products

Baumann, Melissa G.D.; Lorenz, Linda F.; Batterman, Stuart A.; Zhang, Guo–Zheng
2000. Forest Prod. J. 50(9): 75–82.

▷ 4. Assessment of the Environmental Effects Associated With Wooden Bridges Preserved With Creosote, Pentachlorophenol, or Chromated Copper Arsenate

Brooks, Kenneth M.
2000. USDA Forest Serv. Res. Pap. FPL–RP–587. 100 p.

Timber bridges provide an economical alternative to concrete and steel structures, particularly in rural areas with light to moderate vehicle traffic. Wooden components of these bridges are treated with chromated copper arsenate type C (CCA), pentachlorophenol, or creosote to prolong the life of the structure from a few years to many decades. This results in reduced transportation infrastructure costs and increased public safety. However, the preservative used to treat the wooden components in timber bridges is lost to the environment in small amounts over time. The report describes the concentration of wood preservatives lost to adjacent environments and the biological response to these preservatives as environmental contaminants.

▷ 5. Field Performance of Timber Bridges—18. Byron Stress-Laminated Truss Bridge

Dagher, Habib J.; Altimore, Frank M.; Caccese, Vincent; Ritter, Michael A.
2000. USDA Forest Serv. Res. Pap. FPL–RP–588. 20 p.

The Byron bridge was constructed in the fall of 1993 in Byron, Maine. The bridge is a single-span, two-lane, stress-laminated truss structure approximately 46 ft long and 32 ft wide. The truss laminations were produced using chromated copper-arsenate- (CCA-) treated Southern Pine connected with metal plate connectors. This report includes information on the design, construction, and field performance of the bridge. Field performance was monitored for approximately 5 years, beginning shortly after bridge construction. Performance monitoring involved collecting and evaluating data relative to wood moisture content, force level of stressing bars, behavior under static truck loading, and overall structural condition. The field evaluations showed that the Byron bridge is performing well, with no structural or serviceability deficiencies.

Mechanical Grading of Lumber Sawn From Small-Diameter Lodgepole Pine, Ponderosa Pine, and Grand Fir Trees From Northern Idaho

Erikson, Robert G.; Gorman, Thomas M.; Green, David W.; Graham, Dean
2000. Forest Prod. J. 50(7/8): 59–65.

Juvenile Wood Effect in Red Alder: Analysis of Physical and Mechanical Data to Delineate Juvenile and Mature Wood Zones

Evans, Joel W., II; Senft, John F.; Green, David W.
2000. Forest Prod. J. 50(7/8): 75–87.

Railing Systems for Use on Timber Deck Bridges

Faller, Ronald K.; Ritter, Michael A.; Rosson, Barry T.; Duwadi, Sheila R.
1999. *In*: Underground and other structural design issues. Bridges, other structures, and hydraulics and hydrology. Transportation Research Record 1656. Transportation Research Board–National Research Council. Washington, DC: National Academy Press. Pap. 99–1027. 110–119.

▷ 6. Forest Products Laboratory Research Program on Small-Diameter Material

Forest Products Laboratory
2000. USDA Forest Serv. Gen. Tech. Rep. FPL–GTR–110 (Rev.). 31 p.

Forests in the United States contain a significant amount of small-diameter and underutilized material. These overstocked stands not only increase the risk of insect, disease, fire, and drought damage, but also are costly to remove. Finding economical and marketable uses for small-diameter and underutilized material would alleviate these problems while improving watershed health and providing economic opportunities for local communities to help offset forest management costs. An extensive research program at the Forest Products Laboratory of the USDA Forest Service is focused on searching for economical and marketable uses for small-diameter material. The projects described in this report range from conserving timber through improving sawing technology to developing businesses for using small-diameter material.

Design Criteria for Portable Timber Bridge Systems: Static Versus Dynamic Loads

Franklin, John M.; Taylor, S.E.; Morgan, Paul A.; Ritter, M.A.
1999. *In*: Proceedings, 1999 annual international meeting; 1999 July 18–21; Toronto, Ontario, Canada. Pap. No. 99–4208. St. Joseph, MI: American Society of Agricultural Engineers: 19 p.

▷ 7. Machine Grading of Lumber—Practical Concerns for Lumber Producers

Galligan, William L.; McDonald Kent A.
2000. USDA Forest Serv. Gen. Tech. Rep. FPL–GTR–7 (Rev.). 39 p.

Machine lumber grading has been applied in commercial operations in North America since 1963, and research has shown that machine grading can improve the efficient use of wood. However, industry has been reluctant to apply research findings without clear evidence that the change from visual to machine grading will be a profitable one. For instance, mill managers need guidelines on machine grading. This report seeks to document such guidelines so that lumber mills can determine the feasibility of machine grading for their products. The first part of this report discusses the principles of using machine grading to assign properties. In the second part, the methods of machine-graded lumber yield assessment are described by an industry specialist. The final part discusses mill mechanical analysis and cost analysis.

Bending Creep and Load Duration of Douglas-fir 2 by 4s Under Constant Load for up to 12-Plus Years

Gerhards, Charles C.
2000. Wood Fiber Sci. 32(4): 489–501.

Effect of Juvenile Wood on Shear Parallel and Compression

Effects of Phosphoramides on Wood Dimensional Stability

Lee, Hong–Lin; Chen, George C.; Rowell, Roger M.
2000. Taiwan J. For. Sci. 15(1): 137–145.

Effects of Shear Coupling on Shear Properties of Wood

Liu, Jen Y.
2000. Wood Fiber Sci. 32(4): 458–465.

T-Section Glulam Timber Bridge Modules: Modeling and Performance

Morgan, Paul A.; Taylor, S.E.; Ritter, M.A.; Franklin, John M.
1999. *In*: Proceedings, 1999 annual international meeting;1999 July 18–21; Toronto, Ontario, Canada. Pap. No. 99–4207. St. Joseph, MI: American Society of Agricultural Engineers: 22 p

Structural Reliability of Plank Decks

Nowak, Andrzej S.; Eamon, Chris; Ritter, Michael A.
1999. *In*: Avent, R. Richard; Alawady, Mohamed, eds. Structural engineering in the 21st century. Proceedings, 1999 structures congress; 1999 April 18–21; New Orleans, LA. Reston, VA: American Society of Civil Engineers: 688–691.

▷ 8. Potential for Expanding Small-Diameter Timber Market—Assessing Use of Wood Posts in Highway Applications

Paun, Dorothy; Jackson, Gerry
2000. USDA Forest Serv. Gen. Tech. Rep. FPL–GTR–120. 28 p.

Because of a combination of circumstances, there is an overabundance of small-diameter timber available in the United States. There is low demand for this material because it has low value. One way to increase the value, and therefore the demand, for this material is to develop or expand markets where the material can be used. We looked at markets where little or no machining would be required before use because this would make it more feasible to use small-diameter material. One such market is that of wood posts in highway applications. In this study, we gathered information on the current use of posts, both wood and those made from other materials, used in highway applications. Information was gathered using a survey of Department of Transportation engineers from across the United States. We then analyzed the information to assess the possibility of increasing the use of small-diameter timber in the highway application market. We found many opportunities for ways this market could be expanded, but we also found challenges to increasing this market.

Simplified Analysis of Timber Rivet Connections

Stahl, Douglas C.; Marshall, Begel; Wolfe, Ronald W.
2000. *In*: Proceedings, 6th world conference of timber engineering; 2000 July 31–August 3; Whistler, British Columbia, Canada. Vancouver, BC: Venue West Conference Services.

▷ 9. Roof Temperature Histories in Matched Attics in Mississippi and Wisconsin

Winandy, Jerrold E.; Barnes, H. Michael; Hatfield, Cherilyn A.
2000. USDA Forest Serv. Res. Pap. FPL–RP–589. 224 p.

To address the problem of defining actual field temperatures of various wood components in wood-framed roof systems, roof temperatures were monitored in test structures situated in the northern and southern United States (Madison, Wisconsin, and Starkville, Mississippi, respectively). The field exposure structures were intended to simulate the attics of multifamily wood-framed structures for which Model Building Codes sometimes allow the use of fire-retardant-treated roof sheathing. The structures were instrumented to monitor interior attic air, exterior air, inner and outer plywood roof sheathing, and internal rafter temperatures in dry white-shingled structures and both dry and heavily humidified black-shingled structures. Temperatures were recorded from January 1992 through December 1999 in Wisconsin and from January 1996 through December 1999 in Mississippi. The Mississippi exposure generally induced 5°C to 10°C higher temperatures than did the Madison exposure, though the difference in annual maximum "1-h average" temperature of both exposures was usually no more than 3°C to 4°C.

Small-Diameter Log Evaluation for Value-Added Structural Applications

Wolfe, Ronald; Moseley, Cassandra
2000. Forest Prod. J. 50(10): 48–58.

Space-Frame Connection for Small-Diameter Round Timber

Wolfe, Ronald W.; Gjinolli, Agron E., King, John R.
2000. *In*: Proceedings, 6th world conference of timber engineering; 2000 July 31–August 3; Whistler, British Columbia, Canada. Vancouver, BC: Venue West Conference Services.

▷ 10. Dowel-Nut Connection in Douglas-fir Peeler Cores

Wolfe, Ronald W.; King, John R.; Gjinolli, Agron
2000. USDA Forest Serv. Res. Pap. FPL–RP–586. 16 p.

As part of an effort to encourage more efficient use of small-diameter timber, the Forest Products Laboratory cooperated with Geiger Engineers in a study of the structural properties of Douglas-fir peeler cores and the efficacy of a "dowel-nut" connection detail for application in the design of a space frame roof system. A 44.5-mm- (1.75-in.-) diameter dowel-nut connector was found to be economically feasible at a design capacity of 44.5 kN (1.0×10^4 lbf) for a 127-mm- (5-in.-) diameter Douglas-fir peeler core. Variables that affect joint strength and failure mode are location of the dowel nut, wood moisture content, presence of reaction wood, and grain angle orientation with respect to force vectors. The results of this study provide a basis for deriving design properties for peeler core structural application in a space frame roof system and the foundation for establishing a database to support small-diameter timber design and construction standards.

Recycling of Wood Products

Effects of Weathering on Color Loss of Natural Fiber–Thermoplastic Composites

Falk, Robert H.; Felton, Colin; Lundin, Thomas
2000. *In*: Mattoso, Luiz Henrique Capparelli; Leão, Alcides; Frollini, Elisabete, eds. Progress in production and processing of cellulosic fibres and natural polmers. Proceedings, third international symposium on natural polymers and composites—ISNaPol/2000; 2000, May 14–17; São Pedro, SP, Brazil. São Carlos, SP Brazil: Empresa Brasileira de Pesquisa Agropecuária and Universidade de São Paulo; and Botucatu, SP, Brazil: Univaersidade do Estado de São Paulo 382–385.

Surface Chemistry

Durability of One-Part Polyurethane Bonds to Wood Improved by HMR Coupling Agent

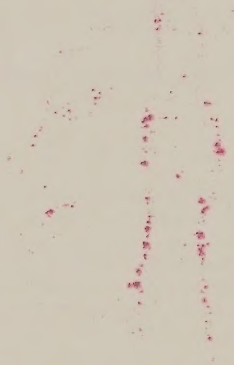
Vick, Charles B.; Okkonen, E. Arnold
2000. Forest Prod. J. 50(10): 69–75.

Timber and Fiber Demand and Technology Assessment

U.S. Forest Products Annual Market Review and Prospects, 1999–2000

Howard, James L.
2000. USDA Forest Serv. Res. Note FPL–RN–0278. 5 p.

The report provides general and statistical information on forests products markets in terms of production, trade, consumption, and prices, as well as specifics describing the current state of the U.S. economy. Market developments are described for sawn softwood, sawn hardwood, softwood and hardwood log trade, pulpwood, wood-based panels, paper and paperboard, fuelwood, and forest product prices. The table presents detailed information and projections for 2001.



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